TABLE 1

SOIL SAMPLING SUMMARY
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

House	Sample	Sample Description	Sampling Rationale
House 1	BDS-[redacted]-SG001	Grab sample of surface soil beneath downspout at east corner of house	No discrete areas of elevated gross gamma activity were detected in the yard; therefore, samples were collected from beneath downspouts and low-lying areas.
	BDS[redacted]-SG002	Grab sample of surface soil beneath downspout at south corner of house	
	BDS[redacted]-SG003	Grab sample of surface soil from low area upgradient of storm sewer drop box	
	BDS-[redacted]-SG004	Grab sample of surface soil from raised flower bed along fence	To assess flower garden soil
	BDS-[redacted]-SG005	Grab sample of surface soil next to rose bushes	
	BDS-[redacted]SC006	Composite sample of surface soil in front yard	Determine if naturally occurring radionuclides are present over wide areas at concentrations distinguishable from background.
	BDS-[redacted]-SC007	Composite sample of surface soil in back yard	
House 2	BDS[redacted]-C-S001	Composite sample of surface soil in front yard	Determine if naturally occurring radionuclides are present over wide areas at concentrations distinguishable from background.
	BDS-[redacted]-C-S002	Composite sample of surface soil in back yard	
	BDS-[redacted]-G-S003	Grab sample of surface soil beneath downspout at southeast corner of house	No discrete areas of elevated gross gamma activity were detected in the yard; therefore, samples were collected from beneath downspouts and low-lying areas.
	BDS-[redacted]-G-S004	Grab sample of surface soil near storm water box drain at northeast corner of backyard	
	BDS-[redacted]-G-S005	Grab sample of surface soil in center of circular flower bed	To assess garden soil
	BDS-[redacted]-G-S006	Grab sample of surface soil in raised flower bed	To assess garden soil
	BDS-[redacted]-G-S007	Grab sample of surface soil beneath downspout at northwest corner of house	No discrete areas of elevated gross gamma activity were detected in the yard; therefore, samples were collected from beneath downspouts and low-lying areas.

4.2 INTERIOR MONITORING AND SAMPLING

Investigation of interior areas included general characterization surveys (including exposure rate, radon, and surface activity surveys) and collection and laboratory analysis of surface dust and bulk dust samples. The following describes interior monitoring and sampling:

4.2.1 Exposure Rate, Radon, and Surface Activity Characterization Surveys

Initial interior walkthroughs of the residences occurred on December 27 and 28, 2016 with homeowners. The intent of the initial walkthrough was to identify living spaces, uses of these spaces, and frequency of occupation. Following initial walkthroughs, exposure rate monitoring, radon monitoring, and surface activity characterization surveys proceeded as follows:

Exposure Rate Measurements

During the walkthrough, a Ludlum Model 44-10 NaI scintillation probe and ratemeter were used to measure exposure rate and to identify presence of gamma sources such as historical consumer products containing radioactive material (e.g., glassware, clocks and watches with radioluminescent painted dials) or building materials with natural radionuclide content (such as stone or brick building materials that may have higher natural radiation levels [U.S. Nuclear Regulatory Commission [NRC] 2011]). These measurements were recorded in the logbook (see Appendix C). During the surveys, some building materials (e.g., bathroom tile in House 1 and brick fireplace and granite countertops in House 2) induced marginally higher exposure rate readings (expected from some earthen building materials); however, overall exposure rate measurements were typical of background environments (e.g., see National Council on Radiation Protection and Measurements [NCRP] 1987, Table 5.4).

Continuous exposure rate measurements were also taken by use of high pressure ionization chambers (HPIC) deployed by EPA at locations within each residence. Continuous measurements from the HPICs are documented in Appendix F, and summarized in Tables 2 and 3 below.

TABLE 2

INTERIOR EXPOSURE RATE MEASUREMENTS – HOUSE 1
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Location	Exposure Rate Measurement	
	Ludlum 44-10 Sodium Iodide Gamma Scintillator	GE Reuter-Stokes RSS-131 High Pressure Ionization Chamber
Kitchen	5-6 µR/hr	-
Garage	5-7 µR/hr	-
Dining Room	5-6 µR/hr	7.1 µR/hr (average over 5.6 hours)
Living Room	5-6 µR/hr	-
Front Door	5-6 µR/hr	-
Hall Bathroom	5-6 µR/hr	-
Office	5-6 µR/hr	-
Master Bedroom	5-6 µR/hr	-
Master Bath	6-7 µR/hr	-
Bedroom 2	6-7 µR/hr	-
Utility Room	6-7 µR/hr	-
Bedroom 3 (basement)	5-6 µR/hr	7.4 µR/hr (average over 5.6 hours)
Basement Den	5-6 µR/hr	-
Workshop	6-7 µR/hr	-

Notes:

µR/hr Microroentgens per hour

TABLE 3

INTERIOR EXPOSURE RATE MEASUREMENTS – HOUSE 2
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Location	Exposure Rate Measurement	
	Ludlum 44-10 Sodium Iodide Gamma Scintillator	GE Reuter-Stokes RSS-131 High Pressure Ionization Chamber
Kitchen	9-10 µR/hr	-
Granite Countertop	14 µR/hr	-
Brick Fireplace	15 µR/hr	-
Dining Room	10-11 µR/hr	8.6 µR/hr (average over 16.9 hours)
Living Room	8-9 µR/hr	-
Hallway	8-9 µR/hr	-
Hall Bathroom	9-10 µR/hr	-
Bedroom #1	8-9 µR/hr	-
Bedroom #2	8-9 µR/hr	-
Master Bedroom	9-10 µR/hr	-
Master Bathroom	10-11 µR/hr	-
Master Shower	10-11 µR/hr	-
Master Closet	10-11 µR/hr	-
Basement (north portion)	10-11 µR/hr	-
Basement (middle portion)	9-10 µR/hr	8.6 µR/hr (average over 16.9 hours)
Basement (south portion)	9-10 µR/hr	-
Basement Drain/Pipes	9-10 µR/hr	-

Notes:

µR/hr Microroentgens per hour

Radon Measurements

Levels of radon (found in homes all over the United States from natural breakdown of uranium in soil, rock, and water) were measured by use of Durridge RAD7 real-time radon detectors. A detector to take radon measurements was placed in the homes (in the basement, if present) during interior sampling activities. A detector was also placed outside to take outdoor ambient radon measurements. During the monitoring, each Durridge RAD7 detector recorded an individual radon measurement every 10 minutes. As specified in the QAPP, these measurements were taken to inform surveyors of potential presence of radon decay products that can deposit onto surfaces and contribute to surface activity levels. Radon measurements are documented in Appendix G, summarized in Table 4 below, and presented as a time-series plot on Exhibit 2. Average radon measurements at House 1 and House 2 (2.0 picoCuries per liter [pCi/L] in the basement bedroom of House 2 and 1.3 pCi/L in the unfinished basement of House 2) were

typical of homes in St. Louis County. (The Missouri Department of Health and Senior Services [MDHSS] reports an average residential radon test result of 3.97 pCi/g in St. Louis County [MDHSS 017].) The average outdoor radon measurement of 0.15 pCi/L was also typical of outdoor environments. (EPA cites an average outdoor radon level of 0.4 pCi/L [EPA 2016a].) Overall, the radon measurements suggested that unusually high concentrations of radon decay products would not be encountered on surfaces during interior monitoring and sampling.

TABLE 4

RADON MEASUREMENTS
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

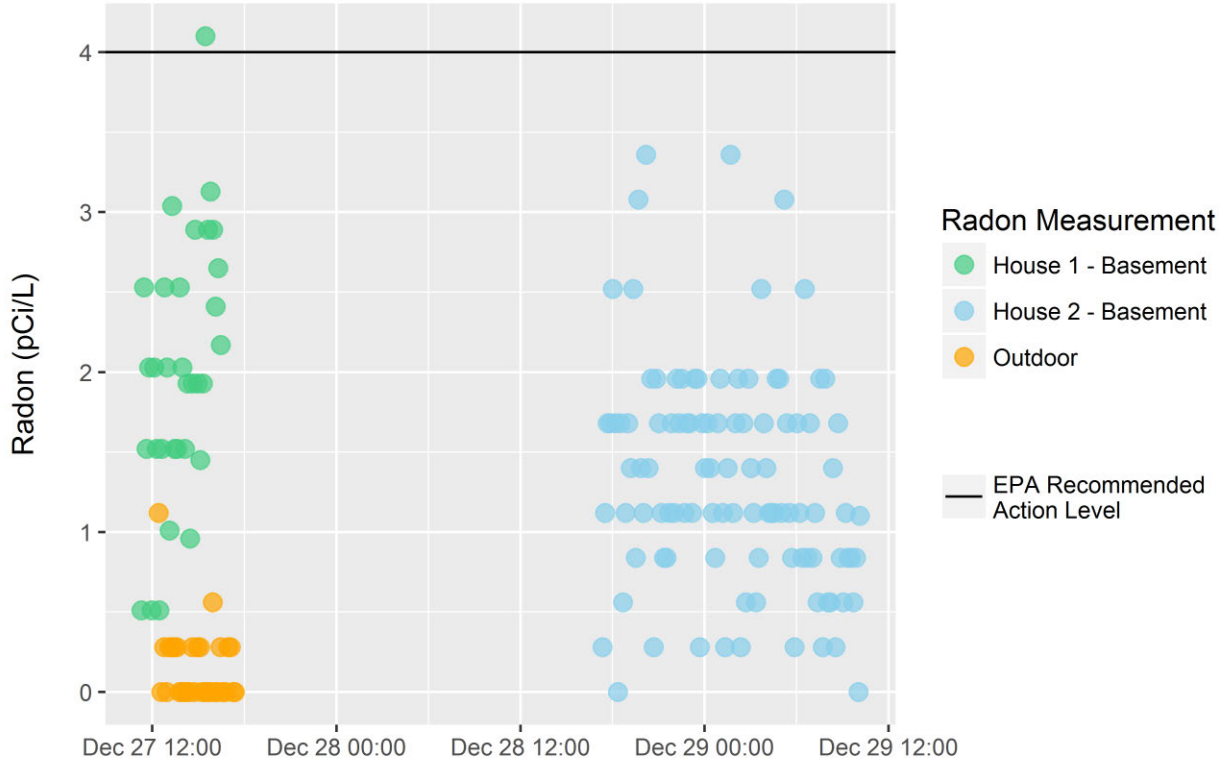
Location	Radon Measurement
	Durridge RAD 7 Radon Detector
Outdoor	0.15 pCi/L (average over 5.0 hours)
House 1: Bedroom 3 (basement)	2.0 pCi/L (average over 5.2 hours)
House 2: Basement	1.3 pCi/L (average over 16.8 hours)

Notes:

pCi/L picoCuries per liter

EXHIBIT 2

INDOOR AND OUTDOOR RADON MEASUREMENTS



The radon measurements were also compared to the EPA-recommended action level of 4 pCi/L (see *A Citizen's Guide to Radon: The guide to Protecting Yourself and Your Family from Radon* [EPA 2016a]). Average radon measurements did not exceed the EPA-recommended action level of 4 pCi/L. However, due to the short duration of the radon testing (about 5 hours in House 1 and 17 hours in House 2), and because no attempts were made to provide "closed-house conditions" during the testing, the results should not be used to assess whether action is warranted to reduce radon levels in the homes. To assess for risks from radon in homes, EPA and the MDHSS recommend testing that begins with an initial short-term test lasting at least 2 days and with the house in a "closed-house" condition. MDHSS recommends testing all homes for radon every 5 to 10 years, and Missouri property owners or residents may request a free residential radon test kit from MDHSS (http://health.mo.gov/living/environment/radon/).

Surface Activity Measurements by Use of Hand-Held Detectors

Measurements of surface activity from various building surface materials were taken by use of hand-held detectors to establish baseline activity levels. Surface activity can include contributions from alpha/beta activity of naturally occurring radioactive materials incorporated into surface materials, deposition of

radon daughter products onto surfaces, and contributions from instrument background. Because building materials differ in background activity levels, various surface types (drywall, tile, carpet, hardwood floors, granite countertops, etc.) were surveyed. During this survey, Ludlum Model 43-90 zinc sulfide (ZnS) scintillation detectors (for alpha activity) and Ludlum Model 44-9 Geiger Muller detectors (for beta and gamma activities) were used to obtain 10 1-minute static measurements from each predominant surface type identified in the home. By use of these measurements, benchmark gross alpha and beta/gamma activities from each surface were determined as the 75th percentile plus 1.5 times the IQR of the approximately 10 static measurements recorded from the surface (as specified in the QAPP). After acquisition of baseline measurements and determination of benchmark values, scanning and static surveys by use of Ludlum Model 43-90 and 44-9 detectors proceeded over numerous surface locations to identify any discrete areas of elevated surface activity. A static 1-minute count of alpha and beta/gamma activity was initiated if a scanning survey identified a suspect discrete elevated area of surface activity. If the static measurement exceeded the corresponding benchmark value, a wipe sample was collected within that area. Most scanning surveys did not identify discrete elevated areas of surface activity, and in those cases, wipe sampling locations were selected as described in Table 3 of the QAPP to investigate both high- and low-occupancy rooms, all entrances to the home, and the laundry room (see Section 4.2.2).

Each of the 1-minute static counts and derivation of benchmark values are documented in the field sheets (see Appendix C) and in Table H-1 of Appendix H. The 1-minute count alpha and beta/gamma activity measurements and the corresponding benchmark values are plotted on Exhibit 3 (House 1 measurements) and Exhibit 4 (House 2 measurements) for each interior surface type (more detailed descriptions of surface types are in Table H-1 of Appendix H). These exhibits distinguish measurements taken during the initial surface characterization survey and used to establish benchmark values (the "baseline" measurements) from measurements prompted by scanning surveys and wipe sampling (the "investigation" measurements). Each 1-minute static count "investigation" measurement was associated with a co-located wipe sample subsequently screened for alpha and beta activity by use of a Ludlum 3030 drawer counter (see Section 4.2.2). Alpha activity measurements of the wipe samples were then used, in part, to select wipe samples for laboratory analysis for specific radionuclides (see Section 4.2.2). As described in Section 6.2, no wipe sample yielded a radionuclide concentration exceeding an EPA BPRG for residential exposure scenario corresponding to a 1 in 10,000 (1E-4) cancer risk.

EXHIBIT 3

1-MINUTE STATIC COUNTS OF INTERIOR SURFACES – HOUSE 1

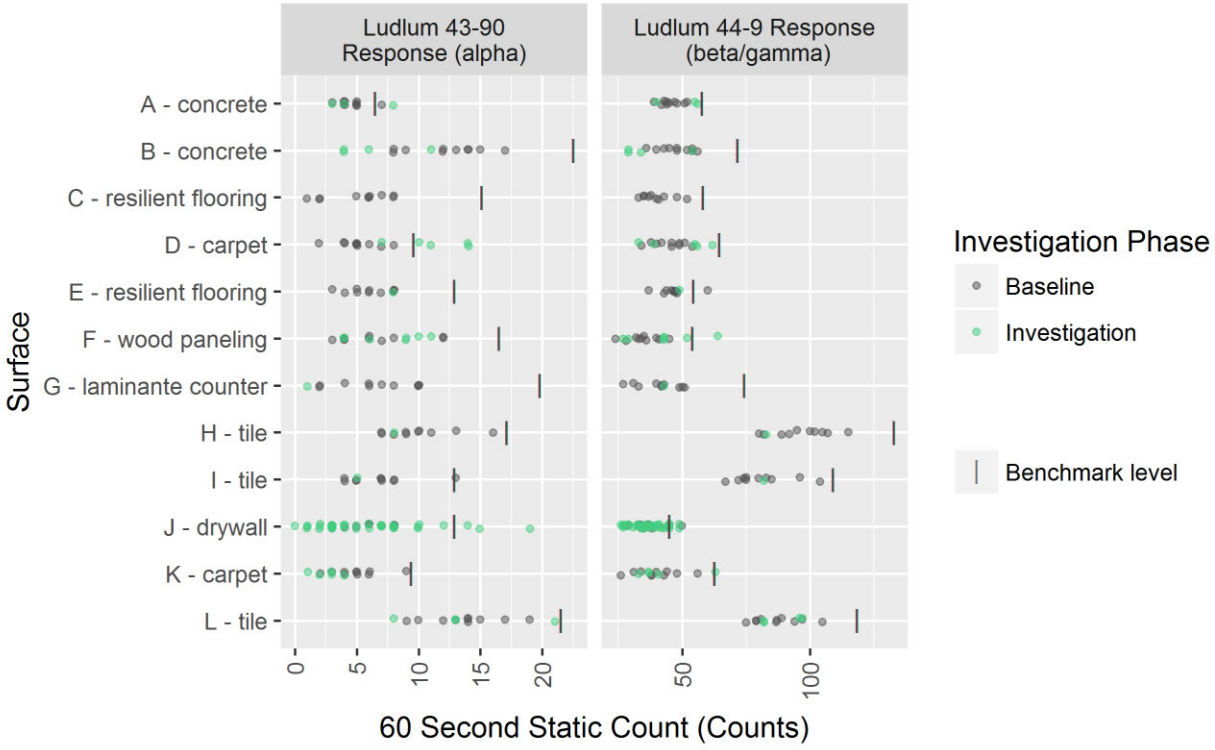
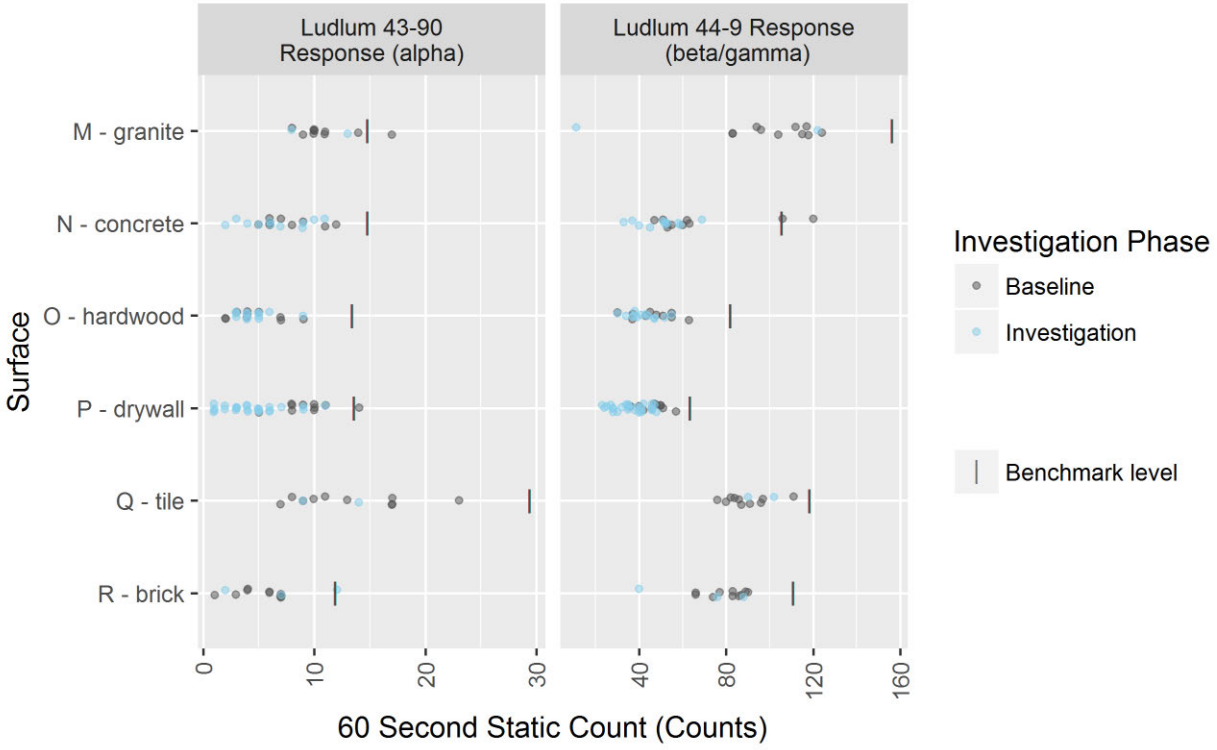


EXHIBIT 4

1-MINUTE STATIC COUNTS OF INTERIOR SURFACES – HOUSE 2



4.2.2 Interior Surface Dust Sampling

Wipe samples were collected to assess presence of radionuclides in settled dust. Surfaces sampled included floors, walls, and other accessible surfaces; floor surfaces near entrances; and floor and wall surfaces near clothes dryers. The surface dust samples were collected onto 1.75-inch-diameter cotton twill coated wipes (or "smears"). At each sample location, a paper template with a 200-square-centimeter (cm^2) cutout (an approximately 14- by 14-inch square) was held over the sampling surface while a wipe was pressed against the sampling surface with moderate pressure and swept over the sampling surface in multiple "S" pattern passes. A new sampling template was used for each wipe sample. The collected wipe samples were placed in glassine envelopes or food-grade releasable plastic bags. Table 5 lists the number of wipe samples collected within each type of area—high-occupancy, low-occupancy, and entrance areas.

TABLE 5

NUMBER OF WIPE SAMPLES COLLECTED
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Room/Location	Number of Wipes Collected (Houses 1 and 2)
High-Occupancy Areas (bedrooms, kitchen, living room, etc.)	92
Low-Occupancy Areas (bathrooms, laundry room, closets, etc.)	55
Entrances	8
Total	129

Each wipe sample was screened by use of a Ludlum 3030 drawer counter to measure gross alpha and beta activity of the wipe sample. A portion of the wipe samples were measured on site to provide preliminary information to field team members (these measurements are recorded on field sheets in Appendix C). The wipe samples were held for several days following collection to allow for decay of short-lived radon daughter products, and then each wipe sample was measured on the Ludlum 3030 drawer counter (on January 4 or 5, 2017); these measurements are detailed in Table H-2 of Appendix H. Per the QAPP, alpha activity results served partly to aid selection of wipe samples to be submitted for laboratory analysis. As prescribed in Table 3 of the QAPP, from each house, wipes selected for laboratory analysis were: (1) the three wipes with the highest alpha counts, (2) the wipe with highest alpha count from each high-occupancy room, and (3) the wipe with highest alpha count from each entrance. Alpha count measurements referenced for this determination were obtained on January 4 and 5, 2017. In this manner, 12 wipe samples per house were selected for laboratory analysis. Two additional field blank wipes per house also were selected. The wipe samples were submitted to ALS in Fort Collins, Colorado, for analyses for uranium and thorium isotopes via alpha spectroscopy, and for radium-226 via detection of radon emanation. Tables 6 and 7 list wipe samples selected for laboratory analysis.

TABLE 6

WIPE SAMPLES SUBMITTED FOR LABORATORY ANALYSIS – HOUSE 1
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Sample Identifier	Sample Description	Area Type	Reason Selected for Laboratory Analysis
BDS[redacted]-W002	Living room, floor	High Occupancy	Highest alpha count of living room
BDS[redacted]-W006	Dining room, wall	High Occupancy	Second highest alpha count among all samples and highest alpha count of dining room
BDS-[redacted]-W014	Kitchen, wall	High Occupancy	Highest alpha count of high-occupancy room
BDS-[redacted]-W019	Bedroom 2, wall	High Occupancy	Highest alpha count of bedroom 2
BDS[redacted]-W034	Office, west wall	High Occupancy	Highest alpha count of office
BDS-[redacted]-W036	Kitchen entrance, floor	Entrance	Entrance sample
BDS-[redacted]-W048	Main entrance, floor	Entrance	Entrance sample
BDS-[redacted]-W049	Master bedroom, west wall	High Occupancy	Highest alpha count of master bedroom
BDS-[redacted]-W052	Laundry, west wall	Low Occupancy	Highest alpha count among all samples
BDS-[redacted]-W058	Basement bedroom, west wall	High Occupancy	Highest alpha count of basement bedroom
BDS-[redacted]-W061	Basement den, floor	High Occupancy	Third-highest alpha count among all samples and highest alpha count of basement den
BDS[redacted]-W074	Garage, floor, entrance	Entrance	Entrance sample
BDS[redacted]-W001	Field blank	Not Applicable	Field blank sample
BDS-[redacted]-W021	Field blank	Not Applicable	Field blank sample

Wipe sample results are presented and evaluated in Section 6.2. As described in Section 6.2, no wipe sample yielded a radionuclide concentration exceeding an EPA BPRG for residential exposure scenario corresponding to a 1 in 10,000 (1E-4) cancer risk.

TABLE 7

WIPE SAMPLES SUBMITTED FOR LABORATORY ANALYSIS – HOUSE 2
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Sample Identifier	Sample Description	Area Type	Reason Selected for Laboratory Analysis
BDS[redacted]-W003	Kitchen countertop	High Occupancy	Highest alpha count of kitchen
BDS[redacted]-W004	Kitchen entrance, floor	Entrance	Entrance sample
BDS-[redacted]-W005	Garage entrance, floor	Entrance	Entrance sample
BDS-[redacted]-W006	Back entrance, floor	Entrance	Highest alpha count among all samples and an entrance sample
BDS-[redacted]-W007	Main entrance, floor	Entrance	Entrance sample
BDS-[redacted]-W010	Dining room, floor	High Occupancy	Second highest alpha count among all samples and highest alpha count of dining room
BDS-[redacted]-W016	Living room, north wall	High Occupancy	Highest alpha count of living room
BDS-[redacted]-W024	Hall linen closet, floor	Low Occupancy	Third-highest alpha count among all samples
BDS[redacted]-W034	Master bedroom, floor	High Occupancy	Highest alpha count of master bedroom
BDS-[redacted]-W036	Bedroom 2, north wall	High Occupancy	Highest alpha count of bedroom 2
BDS-[redacted]-W042	Bedroom 1, north wall	High Occupancy	Highest alpha count of bedroom 1
BDS-[redacted]-W055	Garage, floor	Entrance	Entrance sample
BDS[redacted]-W001	Field blank	Not Applicable	Field blank sample
BDS[redacted]-W061	Field blank	Not Applicable	Field blank sample

Wipe sample results are presented and evaluated in Section 6.2. As described in Section 6.2, no wipe sample yielded a radionuclide concentration exceeding an EPA BPRG for residential exposure scenario corresponding to a 1 in 10,000 (1E-4) cancer risk.

4.2.3 Interior Bulk Dust Sampling

Bulk dust samples of accumulated dust were collected by use of micro-vacuum cartridges to characterize radionuclide concentrations and relative radionuclide ratios in dust. The dust samples were collected by use of a pre-weighed micro-vacuum cassette in accordance with ASTM International (ASTM) D7144 "Standard Practice for Collection of Surface Dust by Micro-vacuum Sampling for Subsequent Metals Determination." To collect a sufficient amount of dust for analysis (the laboratory requested about 3 grams), each bulk dust sample had to include dust collected over multiple surfaces within the selected sampling area. Bulk dust samples, in addition to a field blank samples, were submitted to ALS in Fort

Collins, Colorado, for analyses for uranium and thorium isotopes via alpha spectroscopy, and for radium-226 via detection of radon emanation. Table 8 lists bulk dust samples collected.

TABLE 8

BULK DUST SAMPLES
BRIDGETON DUST SITE, BRIDGETON, MISSOURI

Property	Sample Identifier	Location	Sample Description
House 1	BDS[redacted]-BD01	Utility Room	Collected from several surfaces including floor, walls, tables, shelving, piping, and window sills
	BDS[redacted]-BD01	Garage	Collected from several surfaces in the garage including shelves, wood work bench surface, plastic storage containers, and metal storage container surfaces
	BDS[redacted]-FB	Field blank	Field blank
House 2	BDS-[redacted]-BD01	Basement (unfinished)	Collected from several surfaces including workbench, ballasts, windows sills, shelving, furnace, and dryer
	BDS-[redacted]-FB	Field blank	Field blank

Bulk dust sample results are presented and evaluated in Section 6.3.